Title: Playing exposure does not affect movement characteristics or physiological responses of elite youth footballers during an intensified period of competition.

Running Title: Playing exposure, intensified competition and youth football.

Keywords: Recovery, movement demands, tournament, youth football.

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Abstract

This study investigated the effect of playing time on physiological and perceptual responses to six, 60 min matches played over five days. Thirty youth football players (age = 14.1 ± 0.4 years; body mass = 57.4 ± 12.9 kg; stature 169.3 ± 7.7 cm) were grouped into low (<250 min; LPG, n = 18) and high (≥250 min; HPG, n = 12) match exposure groups and monitored daily for lower body power and perceived wellness. GPS technology was used to assess match running demands in total distance ($m \cdot min^{-1}$), low (<13 $km \cdot h^{-1}$) and high (≥13 $km \cdot h^{-1}$) speed running categories. Hypothesis based testing and effect sizes (ES) were used to analyse data. The HPG performed *moderately* more total distance (103.7 ± 10.4 cf. 90.2 ± 19.7 $m \cdot min^{-1}$, $P = 0.03$; ES=0.74 ± 0.63) and high speed running (26.7 ± 6.6 cf. 20.3 ± 6.5 $m \cdot min^{-1}$, $P = 0.01$; ES=0.87 ± 0.6) than the LPG across all six matches. Differences of a *small* magnitude were observed between groups for lower body power ($P = 0.08$; ES =0.59 ± 0.8) and perceived wellness ($P = 0.09$; ES=0.42 ± 0.4) which were both higher in the HPG. Youth football players appear well equipped to deal with intensified period of competition, such as those experienced in tournaments, irrespective of match exposure.

Introduction

The match demands of youth soccer match play are known and are associated with a player's maturational status, (Buchheit and Mendez-Villanueva 2014a, 2014b), age (Buchheit et al. 2010; Harley et al. 2010) and physical qualities (Castagna et al. 2010), the latter of which discriminate between playing standards (Waldron and Murphy 2013). While these studies focus on single matches, youth players will often compete in tournaments that incorporate congested fixtures. For example, the format of competitions such as the Milk Cup (Northern Ireland) and Cordial Cup (Austria) are contested annually and comprise matches contested over 5-7 consecutive days. However, limited information is available on the characteristics of youth players during such periods of intensified competition (Arruda et al. 2015).

During intensified periods of competition, perceived wellness (Johnston et al., 2012), high intensity activity (Odetoyinbo, Wooster, & Lane, 2009) and total running distance (Carling, Le Gall, & Dupont, 2012) are impaired in student rugby league players and adult footballers, respectively. Increased physical demands associated with greater playing time, prolong the time course of recovery and exacerbate the fatigue response, compromising performance in matches scheduled toward the latter stages of the competitive period (Ekstrand, Walden, & Hagglung, 2004; Rollo et al. 2014) in elite standard international males and sub-elite males, respectively. Conversely, during consecutive days of match simulation there were no significant changes in countermovement jump performance or repeated sprint ability in youth players (Rowsell et al. 2009). Despite reported decrements in lower body function following a single match (Buchheit et al. 2011) and simulated match play (Oliver et al. 2008) the effect on running performance during congested fixture periods with reduced recovery time is equivocal. Accordingly, a more holistic approach to examining the effects of congested fixture periods in youth soccer players using physical performance, recovery and subjective ratings of exertion and wellbeing is warranted (Carling et al. 2015).

After a competitive match, muscle strength (Nedelec et al., 2014; Thorlund, Aagaard, & Madsen, 2009), power (Robineau, Jouaux, Lacroix, & Babault, 2014) and speed (Rollo, Impellizeri, Zago, & Iaia, 2014) are impaired for at least 72 hours. During intensified periods of competition, perceived wellness (Johnston et al., 2012), high intensity activity (Odetoyinbo, Wooster, & Lane, 2009) and total running distance (Carling, Le Gall, & Dupont, 2012) are also negatively affected. Accordingly, it is posited that the physical demands associated with greater playing time prolong the time course of recovery and exacerbate physical and perceptual fatigue response (Ekstrand, Walden, & Hagglung, 2004). However, whether or not such a dose response relationship exists is not clear, especially in the context of intensified youth football competition (Arruda et al. 2015).

The aims of this study were to investigate the response of elite youth football players with different match exposures to an intensified period of competition involving six matches in five days.

Methods

Participants

Thirty elite youth outfield football players (age = 14.1 ± 0.4 years; body mass = 57.4 ± 12.9 kg; stature 169.3 ± 7.7 cm) from the same professional youth academy and age grade volunteered to take part in the study. Data were collected as part of the normal practices employed by staff at the academy and which players and their parents had consented to at the start of the season. The study received institutional ethics approval in accordance with the Declaration of Helsinki.

Design

The tournament was held in Northern Ireland, approximately six hours travel by sea and road from the players' base in Scotland and comprised six, 60-minute matches across five consecutive days. Travel was undertaken to allow one full day of recovery before the first match. Each match was contested over two, 30-minute halves interspersed by 10-minutes of recovery for 'half time'; matches 4 and 5 were played on the same day, interspersed by approximately six hours. Three substitutions were permitted per team, per match, resulting in players involved in high (≥250 minutes; HPG, n = 12) and low (<250 minutes; LPG, n = 18) match exposure. The mean ± SD temperature and humidity over the course of the competition were 13.7 ± 1.2^{o}C and 80.2 ± 5.2% respectively.

Post and between match recovery procedures

Recovery practices after each match included coach-led active cool down and stretching. Fluids and high glycemic carbohydrate snacks were made available after each match for consumption *ad libitum*, in addition to pre and post match meals.

Physical qualities

Three weeks before the tournament, nineteen players completed assessments of selected physical qualities. All assessments were completed in the early evening during normal squad training and on an artificial synthetic surface. After a warm up, players performed a 15 m maximal effort sprint with split timings at 5, 10 and 15 m from a standing start 0.5 m behind the first timing gate. Data were recorded using electronic timing gates (Smartspeed, Fusion Sport, Australia). Players received three attempts to record their fastest time over 15 m and wore their own football boots. The Technical Error of measurement for the assessment was 0.03 s. Players then completed the YoYo Intermittent Endurance Level 2 (YoYo IE2), the protocol for which has been described elsewhere (Bradley et al. 2011). Players were afforded two warnings during the protocol for either failing to arrive on the line at the time denoted by the audio signal or moving off the start line prematurely. The total distance covered was recorded for analysis.

Maturation status

In the same month as the tournament, each player completed measurements of body mass, stature and seated stature to enable the estimation of individual maturity-offset values (Mirwald, Baxter-Jones, Bailey, & Beunen, 2002). This model, when compared to the Bone Mineral Accrual Study (Bailey, 1997), has shown a mean difference in boys of -0.01 years with a standard deviation of 0.49 years (Mirwald et al., 2002). Body mass was assessed daily throughout the tournament using the same set of calibrated scales (SECA 770, Avery Weight-Tronix) with participants wearing only lightweight training shorts.

Lower body muscle power

Lower body power (W) was assessed using a portable force platform (Ergotest Innovation, Porsgrunn, Norway) connected to a laptop (Dell Inspiron 9100, Dell, United Kingdom) using commercially available software (MuscleLab 4020e, Ergotest Innovation). Participants performed two practice jumps before a third from which data were used for analysis. Participants were instructed to flex the knees to approximately 120^{o}, a depth they were habituated with prior to data collection, before jumping as high as possible with their hands remaining on their hips throughout the procedure. The landing and takeoff positions for jumps were assumed to be the same, with any jumps that deviated from the stated procedure repeated. Measures of lower body muscle power were taken at the start of each day before breakfast. This method provides a valid and reliable measurement of lower body power (Johnston et al., 2012).

Perceived wellness

Each morning participants were asked to rate their ‘perceived wellness’ based on individual perceptions of fatigue, muscle soreness, stress, sleep and mood. Each category was rated between five (positive perception of wellness) and one (negative perception of wellness). Scores were recorded for each sub-scale and summated to provide an overall rating of perceived wellness. This scale has been used previously with team sports (McLean, Coutts, Kelly, McGuigan, & Cormack, 2010; Twist, Waldron, Highton, Burt & Daniels, 2012). Measures were taken in private to avoid peer influence on reported scores (Twist & Highton, 2013) and immediately before measures of lower body power.

Assessment of movement demands during match play

Movement demands were measured using portable global positioning system (GPS) devices (SPI-Pro; 5 Hz, GPSports, Canberra, Australia) activated at pitch side, approximately 20 min before the "warm- up" period and worn in an appropriately sized vest. In addition, the time of substitutions was recorded live and used to further truncate raw data. Data were analysed for total distance covered ($m\cdot min^{-1}$), low speed running ($<13\ km\cdot h^{-1}$) and high speed running ($\geq 13\ km\cdot h^{-1}$) (Castagna et al., 2003) with data from the warm up omitted from analysis.

Statistical analysis

Data were checked for normality using Levene's test and deemed appropriate for parametric analysis ($P > 0.05$). Data were analysed using separate independent *t*-tests to assess differences between groups for age, playing time, maturation and movement demands. A two-way repeated measures ANOVA was used to assess differences within and between groups across the five days for power and perceived wellness. Significance was set at $P < 0.05$. Due to the practical nature of the investigation, effect sizes with 90% confidence intervals were also used; thresholds of <0.2, <0.6, <1.2, 1.2-2.0, and >2.0 were considered trivial, small, moderate, large and very large, respectively (Hopkins, Marshall, Batterham, & Hanin, 2009). Data were analysed using SPSS for Windows (PASW Statistics 22.0).

Results

Age and maturation status

No significant difference was observed between HPG and LPG for age (t = 0.28, P = 0.8; ES = 0.1 + 0.1; HPG:14.1 ± 0.56 cf. LPG: 14.1 ± 0.22 years) or maturity offset (t = 0.57, P = 0.6; ES = 0.2 ± 0.2; HPG: 0.67 ± 0.5 cf. LPG: 0.79 ± 0.6 years) respectively.

Physiological assessment data

Differences in distance covered in the YoYo IE2 between the HPG and LPG were *trivial* (t = 0.25, P = 0.8; ES = 0.13 ± 0.1; HPG: 1640 ± 339 m cf. LPG: 1596 ± 316 m). Differences in time to complete a 15 m sprint (t = 1.1, P = 0.3; ES = 0.52 ± 0.5; HPG: 2.58 ± 0.06 s cf. LPG: 2.53 ± 0.12 s) between groups were *small* and non-significant.

Lower body power

Lower body power data are presented in Figure 1. There was no main effect of time (F = 0.52, P = 0.7; ES = 0.11-0.16) or group (F = 3.4, P = 0.08; ES = 0.59 ± 0.8). While a time x group interaction for lower body power was reported (F = 3.5, P =

0.02), *post hoc* analysis revealed no changes for HPG (P = 0.07; ES = 0.08-0.23) or LPG (P = 0.06; ES = 0.12 - 0.36) when comparisons were made to baseline (day 1) data.

INSERT FIGURE 1 NEAR HERE

Perceived wellness

No main effect for time (F = 0.89, P = 0.5; ES = 0.11-0.33), group (F = 3.1, P = 0.09; ES = 0.42 ± 0.4) or time x group interaction (F = 0.74, P = 0.6) was reported. When HPG and LPG were compared for sub-components of perceived wellness, differences in sleep (ES = 0.19 ± 0.2) and soreness (ES = 0.13 ± 0.1) were *trivial,* whilst differences between groups for fatigue (ES = 0.3 ± 0.3), mood (ES = 0.4 ± 0.4) and stress (ES = 0.5 ± 0.5) were *small* (Table 1).

INSERT TABLE 1 NEAR HERE

Movement demands

Match characteristics, low and high speed running

There were *large* differences in playing time (t = 6.7, P < 0.01; ES= 3.1 ± 0.9) and total distance (t = 9.5, P < 0.01; ES = 3.53 ± 0.9) across all six matches, with higher values reported for the HPG compared to LPG. When distance covered was reported relative to playing time (i.e. $m\cdot min^{-1}$), HPG still demonstrated *moderate*ly higher values compared to the LPG (t = 2.2, P = 0.03; ES = 0.74 ± 0.63). There were *large* differences in absolute low speed running between groups with higher values in the HPG (t = 7.9, P < 0.01; ES = 3.2 ± 0.8). However, when expressed relative to minutes played, differences were only *small* and not statistically significant (t = 1.0, P = 0.3; ES = 0.5 ± 0.5). Differences in absolute high speed running (t = 9.0, P < 0.01; ES = 2.9 ± 0.8) and when expressed relative to minutes played (t = 2.6, P < 0.01; ES = 0.87 ± 0.6) were *large* and *moderate*, respectively, with higher values in the HPG. Movement data are shown in Table 2.

INSERT TABLE 2 NEAR HERE

Discussion

Despite higher match exposure, total and relative high intensity running ($m \cdot min^{-1}$) in the HPG, there were no differences in lower body power or perceived wellness compared to the LPG. Whilst perceived wellness scores were higher (indicating better wellness) in the LPG, lower body muscle power was lower across the week. These differences did not reach statistical significance and yielded effect sizes no greater than *small*. Our findings indicate that intensified periods of competition, irrespective of match exposure, did not impair performance or induce neuromuscular or perceptual fatigue in youth football players.

Reductions in CMJ performance represent the development of neuromuscular fatigue and have been reported in adult team sport players during short periods of intense competition (Johnston et al., 2013; Rollo et al., 2014). However, only *trivial* and *small* changes in CMJ from baseline were reported in our players over time, reaffirming previous findings reporting no change in jump performance amongst youth soccer players under tournament conditions (Rowsell, Coutts, Reaburn & Hill-Haas, 2009). No difference in CMJ was reported between groups, in contrast to findings in adult players where reductions in lower body power showed a *moderate* correlation with playing time (Cormack et al., 2008). Impairments of muscle function after muscle damaging exercise are much less severe in children compared to adults (Marginson, Rowlands, Gleeson & Eston, 2005). Moreover, regular training and competition in this group of players throughout the year may have protected muscle function via the repeated bout effect (McHugh, 2003). Therefore, that CMJ was unchanged after what would be considered to be damaging exercise is not unsurprising and may be viewed as evidence of differences in neuromuscular characteristics between adults and children (Marginson et al., 2005; Dotan, Mutchell, & Cohen, 2012).

Perceptions of wellness are impaired by intensified periods of competition and training in adult (Johnston et al., 2012; McLean et al., 2010) and youth team sport players (Faude, Steffen, Kellmann, & Meyer, 2014; Johnston, Gabbett & Jenkins, 2015). Conversely, our findings demonstrate youth footballers playing in an elite tournament with intensified match play reported no changes in perceived wellness. It should be noted however that pre competition wellness scores were lower than reported elsewhere, albeit not in youth footballers (Hogarth et al. 2015). Although on full day of recovery was permitted between arrival at the tournament venue and the first match, coaches should consider the impact that travel and unfamiliar surroundings, might have on the perceived wellness of youth players. No changes in perceived muscle soreness (a sub-scale of perceived wellness) is consistent with preserved muscle function and the notion of less severe symptoms of tissue damage in young people (Marginson et al., 2005). Additionally, higher daily habitual training activity of this group meant that the tournament duration and intensity might have been insufficient to elucidate meaningful changes in perceived wellness such as those reported over the course of a season in youth soccer players (Faude et al., 2014). Interestingly, the stress sub-scale of perceived wellness was higher in the LPG and might well have arisen from competitive anxiety and/or reduced self-efficacy due to limited match exposure (dos Santos et al., 2014). This finding suggests coaches give consideration to recovery strategies that target psychological as well as physical recovery.

When assessed in relative terms ($m \cdot min^{-1}$), the HPG performed *moderately* more high intensity and total running than the LPG. Between group differences in movement demands cannot be explained by maturity offset or age where *trivial* and *small* differences were observed, respectively. Data from the present study, similar to that reported for adult cohorts, suggest running performance is not affected by the limited recovery time indicative of intensified periods of competition, or indeed match exposure time.

Conclusion

These data suggest that an intensified competition does not affect lower body power, perceived wellness or running performance in elite youth soccer players irrespective of match exposure.

Practical Implications

Coaches working with elite youth players during tournaments where fixtures are played on successive days should not be overly concerned about neuromuscular or perceptual fatigue influencing match running performance. Moreover, match exposure does not seem to negatively affect running performance. However, coaches and practitioners should pay particular attention to the training and playing loads incurred by youth players in the days and weeks after intensified periods of competition.

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Table 1. Means ± SD for perceived wellness scores between high (HPG) and low (LPG) match exposure groups

		Day one	Day two	Day three	Day four	Day five
Fatigue						
	HPG	2.3 ± 0.8	2.5 ± 0.9	2.6 ± 0.7	2.3 ± 0.6	2.8 ± 0.5
	LPG	2.6 ± 0.6	2.8 ± 0.8	2.6 ± 0.6	2.6 ± 0.7	2.6 ± 0.6
	ES	0.40	0.56	0.04	0.48	0.20
Sleep						
	HPG	2.4 ± 0.9	1.8 ± 0.6	2.0 ± 0.0	2.2 ± 0.4	2.2 ± 0.4
	LPG	2.2 ± 0.4	2.2 ± 0.6	2.3 ± 0.5	2.1 ± 0.5	2.0 ± 0.5
	ES	0.36	0.73	0.63	0.10	0.32
Soreness						
	HPG	1.8 ± 0.7	2.3 ± 0.8	2.5 ± 1.1	2.8 ± 0.9	2.8 ± 0.8
	LPG	2.4 ± 0.9	2.5 ± 0.8	2.6 ± 0.7	2.4 ± 0.6	2.5 ± 0.7
	ES	0.74	0.37	0.20	0.37	0.23
Stress						
	HPG	1.9 ± 0.8	1.8 ± 0.6	1.8 ± 0.7	2.0 ± 0.4	1.8 ± 0.6
	LPG	2.1 ± 0.6	2.0 ± 0.8	2.2 ± 0.6	2.4 ± 0.5	2.4 ± 0.5
	ES	0.30	0.39	0.60	0.60	0.86
Mood						
	HPG	1.5 ± 0.5	1.8 ± 0.6	1.8 ± 0.6	1.6 ± 0.5	1.8 ± 0.7
	LPG	1.7 ± 0.5	1.8 ± 0.3	1.7 ± 0.5	1.8 ± 0.3	1.7 ± 0.4
	ES	0.54	0.27	0.05	0.59	0.05
Totals						
	HPG	10.0 ± 2.6	10.1 ± 2.7	10.7 ± 2.2	10.8 ± 1.9	11.3 ± 1.6
	LPG	11.2 ± 1.5	11.5 ± 2.5	11.6 ± 1.9	11.5 ± 1.4	11.3 ± 1.4
	ES	0.59	0.74	0.47	0.33	0.04

HPG = ≥ 250 playing minutes LPG = < 250 playing minutes. Effect sizes (ES) classified as trivial (<0.2), small (<0.6), moderate (<1.2) and large (>2.0) (Hopkins et al., 2009).

Table 2. Means ± SD for game time, total distance, low intensity running (<13 $km{\cdot}h^{-1}$; LIR) and high intensity running (≥13$km{\cdot}h^{-1}$; HIR) for high (HPG) and low (LPG) match exposure groups.

	HPG	LPG	P value	ES
Game time				
Playing minutes	287.5 ± 32.9	158.9 ± 59.2	<0.001	1.6
Total distance				
Absolute (m)	29560.3 ± 3767.3	13729.2 ± 4871.5	<0.001	1.75
Relative to time played ($m{\cdot}min^{-1}$)	103.7 ± 10.4	90.2 ± 19.7	0.03	0.76
Low Intensity Running (<13 $km{\cdot}h^{-1}$)				
Absolute (m)	21243.7 ± 2735.7	10753.9 ± 3977.9	<0.001	1.67
Relative to time played ($m{\cdot}min^{-1}$)	74.4 ± 4.2	70.0 ± 14.2	0.32	0.38
High Intensity Running (≥13km.h)				
Absolute (m)	7575.6 ± 1820.6	2983.2 ± 972.1	<0.001	1.73
Relative to time played ($m{\cdot}min^{-1}$)	26.7 ± 6.6	20.3 ± 6.5	0.01	0.89

HPG = ≥ 250 playing minutes LPG = < 250 playing minutes. Effect sizes (ES) classified as trivial (<0.2), small (<0.6), moderate (<1.2) and large (>2.0) (Hopkins et al., 2009)